E4113: Introduction to Mathematical Economics

Logistical Information

Classes: Tuesday and Thursday, 2:30 – 3:45 pm., Spring 2008, 235 Blegen Hall.
Instructor: David Rahman (dmr@umn.edu, econ.umn.edu/˜dmr).
Office hours: Thursday, 4:00 – 6:00 or by appointment, 1115 Heller Hall.
Prerequisites: Economics 3101, 3102, Mathematics 1271, 1272, 2243 or equivalent.
Students should know basic linear algebra, calculus, and reading/writing proofs.

Course Description

The purpose of this course is to introduce students to the mathematical language of economics. Intuitively, economics is the study of how society organizes itself: why people do what they do, why they give what they give, why they get what they get. Formally, economists model behavior as the result of an optimization problem—be it the behavior of an individual, an institution, or a society.

Optimization is the key idea that will be formalized in this course to build a framework for rigorous economic reasoning. The course is divided into three parts: (i) linear programming, (ii) concave programming, and (iii) economic applications.

Assessment

Two Midterms (in class): Thursday, February 21 and April 3, 2008.
Final exam: Thursday, May 15, 2008, 10:30 – 12:30 pm., 235 Blegen Hall.
Homework: Six problem sets distributed in class every two weeks, starting week 2.
Grading: A student's overall grade will be calculated according to the formula below.

$$\text{overall} = \tfrac{3}{4}\max\{\text{final}, \tfrac{1}{2}\text{ final} + \tfrac{1}{2}\text{ midterm average}\} + \tfrac{1}{4}\text{homework average}$$

Reading

Dixit, A. K., *Optimization in Economic Theory*, Oxford University Press.
Simon, C. P., and L. Blume, *Mathematics for Economists*, W. W. Norton & Co.
Vohra, R. V., *Advanced Mathematical Economics*, Routledge.

Tentative Outline

Part I: Linear Programming with Applications

1. **Linear Equations** (1/22, 1/24)
   - Statement of the problem, conditions for existence of a solution.
   - Applications: Input-output analysis, dynamical systems, Markov chains.
2. **Separating Hyperplane Theorem** (1/29, 1/31)
   - Convexity, hyperplanes, polyhedra, statement of the theorem.
   - Proof of the theorem.
3. **Linear Inequalities** (2/5, 2/7)
   - Theorem of the Alternative, Farkas' Lemma, Minimax Theorem.
   - Fundamental Theorem of Linear Programming.
4. **Applications I: Asset Pricing and Cooperative Games** (2/12, 2/14)
   - Asset pricing, definition of the core, existence.
   - Assignment model, core equivalence.
5. **Applications II: Non-Cooperative Games** (2/19, 2/21)
   - Expected utility, zero-sum games, correlated equilibrium.
   - *First Midterm*: February 21, 2:30 – 3:45 pm., 235 Blegen Hall.

Part II: Concave Programming and the Lagrangean

6. **Unconstrained Optimization** (2/26, 2/28)
   - Necessary conditions.
   - Sufficient conditions.
7. **Constrained Optimization** (3/4, 3/6)
   - Lagrangean, necessary conditions, sufficient conditions.
   - Applications: Consumer theory, profit-maximization, monopoly.

8. **Quasiconcave Programming** (3/11, 3/13)
   - Quasiconcave functions, necessary conditions for a maximum.
   - Sufficient conditions for a maximum.

   SPRING BREAK (3/18, 3/20)

9. **Kuhn-Tucker Theorem** (3/25, 3/27)
   - Corner solutions, equality vs. inequality constraints.
   - Constraint qualification, statement and proof of the theorem.

10. **Envelope Theorem** (4/1, 4/3)
    - Unconstrained and constrained, indirect utility, Slutsky equation.
    - *Second Midterm*: April 3, 2:30 – 3:45 pm., 235 Blegen Hall.

Part III: Economic Applications

11. **Welfare Economics** (4/8, 4/10)
    - First welfare theorem with quasi-linear utility, core convergence.
    - Public goods and Lindahl pricing.

12. **Choice under Uncertainty** (4/15, 4/17)
    - Risk and risk aversion.
    - Portfolio choice, asset pricing.

13. **Optimization over Time** (4/22, 4/24)
    - From finite to infinite time horizon, discounting, present value.
    - Maximum principle.

14. **Dynamic Programming** (4/29, 5/1)
    - Bellman's equation.
    - Transversality, steady states.

15. **Contract Theory** (5/6, 5/8)
    - Principal-agent model.
    - Many agents.

Grading Standards and Academic Dishonesty

The Faculty Senate recommends that the following (or an equivalent) statement of grading standards be incorporated into every syllabus:

University Grading Standards

- A: Achievement that is outstanding relative to the level necessary to meet course requirements.
- B: Achievement that is significantly above the level necessary to meet course requirements.
- C: Achievement that meets the course requirements in every respect.
- D: Achievement that is worthy of credit even though it fails to meet fully the course requirements.
- S: Achievement that is satisfactory, which is equivalent to a $C-$ or better (achievement required for an S is at the discretion of the instructor but may be no lower than a $C-$).
- F (or N): Represents failure (or no credit) and signifies that the work was either (1) completed but at a level of achievement that is not worthy of credit or (2) was not completed and there was no agreement between the instructor and the student that the student would be awarded an I.
- I (Incomplete): Assigned at the discretion of the instructor when, due to extraordinary circumstances, e.g., hospitalization, a student is prevented from completing the work of the course on time. Requires a written agreement between instructor and student.

Academic Dishonesty

Academic dishonesty in any portion of the academic work for a course shall be grounds for awarding a grade of F or N for the entire course.

Credits and Workload Expectations

For undergraduate courses, one credit is defined as equivalent to an average of three hours of learning effort per week (over a full semester) necessary for an average student to achieve an average grade in the course. For example, a student taking a three credit course that meets for three hours a week should expect to spend an additional six hours a week on coursework outside the classroom.